Drivers for farmers' contribution in an innovation process for a new water protection measure – Building social acceptance through a gypsum pilot project

Venla Ala-Harja
Master's thesis
Environmental Economics
Department of Economics
and Management
University of Helsinki
November 2020

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

Tiedekunta – Fakultet – Faculty	Koulutusohjelma – Utbildingsprogram – Degree Programme
Agriculture and Forestry	Environmental Economics

Tekijä – Författare – Author

Ala-Harja, Venla J

Työn nimi – Arbetets titel – Title

Drivers for farmers' contribution in an innovation process for a new water protection measure – Building social acceptance through a gypsum pilot project

Oppiaine/Opintosuunta – Läroämne/Studieinriktning – Subject/Study track

Environmental economics

Työn laji – Arbetets art – Level	Aika – Datum – Month and year	Sivumäärä – Sidoantal – Number of pages
Master's thesis	November 2020	53

Tiivistelmä – Referat – Abstract

The SAVE gypsum pilot project investigated the suitability of gypsum amendment as a new means of agricultural water protection in cooperation with local farmers. The participating farmers acted not only as testers of the method, but also as co-developers, whose expertise, observations and experience were used as part of the effort to produce a new cost-effective, widely accepted method of water protection from gypsum.

The study investigated the factors that influenced the participation of farmers in the pilot project developing a new potential water protection method and, on the other hand, the factors that influenced their acceptance of gypsum amendment. The results tell about the acceptance of the method from the point of view of future users and about which factors in the method are relevant for farmers. The information helps in the evaluation, development, furthering and marketing of the method.

The thesis was based on research related co-creation of innovations and acceptance of new agri-environmental methods. The material of the study was the answers of the farmers' surveys of the SAVE gypsum project. The surveys were conducted for three consecutive winters, beginning in December 2016 and ending in January 2019. The data were analyzed using descriptive statistics, factor analysis, logistic regression analysis and cross-tabulation (χ^2 test and McNemar test).

According to the results, the main reasons for participating in the pilot were related to the improvement of the environmental reputation of the Finnish agricultural sector, curiosity about the effects of gypsum and the opportunity to promote water protection and related research. These factors, as well as the desire to strengthen Finnish agriculture, the sense of responsibility and the sense of community of farmers, also best predicted the acceptance of the method for reasons of participation. Positive factors in approving the method were the perception of local people's positive attitude towards the method, the experience of gypsum as an easy method for water protection, and the fact that the farmer was not concerned about the effects of gypsum on field condition and productivity or the surrounding environment

Avainsanat – Nyckelord – Keywords

ecoinnovation, innovation process, agricultural water protection, acceptance, adoption, agricultural innovation, co-creation

Ohjaaja tai ohjaajat – Handledare – Supervisor or supervisors

Markku Ollikainen, Anna-Kaisa Kosenius

Säilytyspaikka – Förvaringställe – Where deposited

Helda e-thesis

Muita tietoja – Övriga uppgifter – Additional information

Tiedekunta – Fakultet – Faculty	Koulutusohjelma – Utbildingsprogram – Degree Programme
Maatalous-metsätieteellinen	Ympäristöekonomia

Tekijä – Författare – Author

Ala-Harja, Venla J

Työn nimi – Arbetets titel – Title

Viljelijöiden osallistuminen innovaatioprosessiin kipsipilotissa

Oppiaine/Opintosuunta – Läroämne/Studieinriktning – Subject/Study track

Ympäristöekonomia

Työn laji – Arbetets art – Level	Aika – Datum – Month and year	Sivumäärä – Sidoantal – Number of pages
Pro gradu	Marraskuu 2020	53

Tiivistelmä – Referat – Abstract

SAVE-kipsihankkeessa selvitettiin kipsikäsittelyn soveltuvuutta uudeksi maatalouden vesiensuojelukeinoksi yhteistyössä paikallisten viljelijöiden kanssa. Hankkeeseen osallistuvat viljelijät toimivat paitsi menetelmän testaajina, myös yhteiskehittäjinä, joiden asiantuntemusta, havaintoja ja kokemuksia käytettiin osana pyrkimystä tuottaa kipsistä uusi kustannustehokas, laajasti hyväksytty vesiensuojelumenetelmä.

Tutkielmassa selvitettiin, mitkä tekijät vaikuttivat viljelijöiden osallistumiseen uutta potentiaalista vesiensuojelumenetelmää kehittävään pilottihankkeeseen ja toisaalta mitkä tekijät vaikuttivat heidän hyväksyntäänsä kipsikäsittelyä kohtaan. Tulokset kertovat menetelmän vastaanotosta tulevien käyttäjien näkökulmasta sekä siitä mitkä tekijät menetelmässä ovat olennaisia viljelijöille. Tieto auttaa menetelmän arvioinnissa, kehittämisessä, eteenpäin viennissä sekä markkinoinnissa. Tutkielma pohjautui innovaatioiden yhteiskehitystutkimukseen sekä uusien maatalouden ympäristömenetelmien hyväksyntää koskevaan tutkimukseen.

Tutkielman aineistona käytettiin SAVE-kipsihankkeen viljelijäkyselyiden vastauksia. Kyselyt toteutettiin kolmena peräkkäisenä talvena, alkaen joulukuusta 2016, päättyen tammikuuhun 2019. Aineistoa analysoitiin käyttäen suoria jakaumia, faktorianalyysiä, logistista regressioanalyysia sekä ristiintaulukointia (testeinä χ^2-testi ja McNemar testi).

Tulosten mukaan merkittävimmät syyt osallistua hankkeeseen liittyivät maatalouden ympäristömaineen parantamiseen, uteliaisuuteen kipsin vaikutuksista sekä mahdollisuuteen edistää vesiensuojelua ja siihen liittyvää tutkimusta. Nämä tekijät, sekä halu vahvistaa suomalaista maataloutta, velvollisuuden tunne sekä tunne viljelijöiden yhteisöllisyydestä, ennustivat osallistumissyistä parhaiten myös menetelmän hyväksyntää. Myönteisesti vaikuttavia tekijöitä menetelmän hyväksymisessä olivat käsitys paikallisten ihmisten myönteisestä suhtautumisesta menetelmää kohtaan, kipsin kokeminen helpoksi menetelmäksi vesiensuojeluun sekä se, ettei viljelijä ollut huolissaan kipsin vaikutuksista peltojen kuntoon ja tuottavuuteen tai ympäröivään luontoon.

Avainsanat – Nyckelord – Keywords

ekoinnovaatio, maatalouden vesiensuojelu, yhteiskehittäminen, innovaatioprosessi, innovaation hyväksyntä, innovaation omaksuminen

Ohjaaja tai ohjaajat – Handledare – Supervisor or supervisors

Markku Ollikainen, Anna-Kaisa Kosenius

Säilytyspaikka – Förvaringställe – Where deposited

Helda e-thesis

Muita tietoja – Övriga uppgifter – Additional information

Table of Contents

1. Introduction

1.1 Reducing eutrophication of the Baltic Sea

The Baltic Sea in Northern Europe is one of the world‘s largest brackish water areas. Due to being relatively isolated and having a small total water volume, it is particularly vulnerable to environmental pressures. (HELCOM, 2020.) The overall ecological state of the Baltic Sea has been described as “not good” by most indicators and 97 percent of its region has been assessed as eutrophied (HELCOM, State of the Baltic Sea, 2018). Agriculture is a major source of phosphorus loading (60-80% of diffuse and almost half of total waterborne inputs), which contributes to eutrophication of the sea and is the key limiting nutrient for eutrophication along with nitrogen. (HELCOM, 2020). While some point source nutrient loading has been reduced successfully over the past decades, measures in agriculture have not generated major reductions. (Suomen meriympäristön tila 2018 (2018)).

Gypsum amendment of fields ($CaSO_4 \cdot 2\ H_2O$) is a potential promising new agricultural water protection measure that in some earlier studies has been discovered to significantly reduce both particulate and dissolved phosphorus leaching from agricultural fields into water bodies (Ekholm et al. 2012: Jaakkola et al. 2012). Gypsum increases the ionic strength of the soil, which causes soil particles to form larger particles, which again results in reduction of erosion and reduction of phosphorus loading (Ekholm et al. 2012).

In the light of these earlier results, gypsum might be considered a potential eco-innovation, an innovation that reduces environmental impacts (definition by OECD 2010. MEI report), and new response to a difficult problem that has been found difficult to solve with current measures (Aakkula, Aakkula, & Leppänen, 2014).

The costs of using gypsum as a water protection measure have been estimated to be substantially lower than the costs of existing measures in reducing agricultural phosphorus loading (Lötjönen & Ollikainen, 2019, Hyytiäinen and Ollikainen 2012). Use of gypsum as an agricultural water protection measure does not negatively affect yields or farmland use and applying gypsum is comparable to lime spreading, which is a familiar agricultural practice for farmers. Therefore, it does not reduce farmers’ revenue or require investments on machinery or complex new expertise from farmers. Suitable gypsum for agricultural use is available as a by-product from various sources, for

example in Finland, from fertilizer production. The suggested cost-effectiveness of this measure could imply that it might enable larger environmental improvements than the existing water protection measures with a same budget. This would make it a preferable choice for society as a whole in terms of EU and nationally funded environment payments that cover the costs of agri-environmental measures (voluntary environmental commitments) for farmers.

1.2 Social acceptance of eco-innovation

To achieve extensively the reductions gypsum might offer on phosphorus loads and thereby environmental improvements in water bodies, the measure should be used in a large-scale manner on suitable agricultural fields. This would require wide consensus on the feasibility and effectiveness of the measure among different stakeholders. Social acceptance has been recognized as one of the key components in achieving environmental targets of successful eco-innovations in (Stosic, Milutinovic, Zakic and Zivkovic 2016) and is a potential constraining factor in implementing new measures, which should not be neglected (Wüstenhagen, Wolsink and Bürer 2007). Therefore, also EU calls out to further the social acceptance of eco-innovations to bring the targeted environmental improvements (European Commission 2011b)

As farmers make decisions concerning their own fields, the new measure's acceptance among farmers is crucial in pursuing the water protection effects (Blackstock et al., 2010; Vanslembrouck et al. 2002). From the society's viewpoint, reductions in nutrient loading lead into benefits that are public goods and mostly benefit society as a whole rather than individual farmers themselves. Hence, farmers' interest to deliver public goods at their own cost is limited. In general, socially optimal use of eco-innovations or sustainable agricultural practices, often requires use of policy instruments, e.g. financial support (del Río, Peñasco and Romero-JordánRenning, 2016, Rennings 2000) This would apply to gypsum as well. Implementation of adequate policy measures and financial support demands political support. To achieve the necessary support, the effectiveness and feasibility of the method should be clear and convincing and tested sufficiently.

On the other hand, achieving the desired effects of the measures, i.e. applicability, the extent of adoption, usability, effectiveness, and thereby environmental improvements, requires choosing the adequate policy tools. To maximize the efficacy of such policies, it is important to identify drivers that are relevant to the adoption and to create a framework that appeals to potential adopters of the

new practice (Pannell & Claassen, 2020). In addition, the communication about the eco-innovation plays an important role in implementing new measures in practice.

One way to promote social acceptability of new measures is to engage farmers in the field pilot organized in the design phase. Literature about designing new agri-environmental measures presses the importance of regarding farmers' perspective concerning the new measure and drivers of adoption from the farmers' point of view in order to accomplish the potential environmental outcomes. Instead of linear top-down approach, successful innovations in agriculture are nowadays seen as a result of a multifaceted innovation process, where mutual (social, co-) learning and information exchange advance the outcome and enhance the adoption. (Hasler et al, 2017; Bock, 2012; Baars, 2011; Knickel et. al, 2009.)

1.3 The gypsum pilot project and the aim of thesis

In Southwest Finland, a large-scale pilot was organized (2016–18) in order to further test and co-design the measure and inform the stakeholders of the feasibility, safety and effectiveness of the method. Objectives of the pilot were: To test the feasibility of the measure for large-scale use (e.g. logistics and applicability), to further test the efficiency of gypsum as a water protection method, to study the safety of the measure for river biota and the impacts on fields and yield as well as acceptance among farmers and to enhance awareness of gypsum among stakeholders. The pilot enabled all the testing and research, and offered a platform for collaboration, communication and knowledge change between stakeholders. As such, the project functioned in part as a social innovation platform which also enabled the use of valuable practitioner knowledge of farmers, who served as user innovators in the pilot.

The aim of this thesis is to study the drivers that affected farmers' contribution to the innovation process. The research questions are:

1. Which factors affected farmers' decision to participate in the pilot? Farmers' participation enabled the creation of the pilot and therefore outcomes of it. In addition to acting as co-innovators and testing a new method, farmers' participation was also a decision to adopt a new measure on their fields. The drivers for their participation show how farmers responded to the innovation process for gypsum as a new potential water protection measure in agriculture.

2. Which factors affected farmers' acceptance towards the measure? Information about farmers' acceptance and drivers for it are important part of innovation process: Measuring acceptance is essential information for stakeholders as such and drivers for their acceptance reveal which factors are relevant for farmers' acceptance. Drivers also show how farmers experienced the use of gypsum on their fields and how they see it after their own onsite experience, which is essential for designing and marketing the future use of the new measure.

The research questions will be studied utilizing data from farmer surveys that were carried out yearly during the three-year period of the pilot project. Through these questionnaires farmers reported about their motivations for participation, attitudes, experiences and perceptions. I will explore the factors affecting the acceptance and the adoption of gypsum treatment of fields as a new agricultural water protection measure. The survey data will be analyzed with adequate methods. The findings will be discussed in the light of previous literature and concluded. The thesis contributes to the earlier literature concerning user innovation, farmers' adoption and acceptance of new agricultural methods. In addition, it illuminates farmers' response to a new water protection measure, the gypsum amendment.

This work continues as follows: First, I will introduce relevant innovation concepts and explain the innovation process present in the pilot through innovation literature. Based on that, I'll describe the role and contribution of pilot farmers in the context of gypsum pilot. After that, I will review previous co-innovation literature and literature about adoption of sustainable agricultural measures concerning the drivers of participation in processes that have similar features as farmers' output. Then, I'll present material and methods, results and finally, discuss the results.

2. Framework

2.1 Definition of (eco-) innovation

OECD's Oslo Manual (2005) describes innovation as an "implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations". Innovation in general is widely considered as a central source of economic growth, productivity and social welfare (OECD & Statistical Office of the European Communities, 2005). According to early innovation theorist, economist Joseph Schumpeter, innovation causes change and development through "creative destruction" that reforms society from within by continuous transition. New improved solutions replace the old ones and economic, social, institutional structures change (Schumpeter, 1934; Oslo manual: Fagerberg et al. 2012)

Development and economic growth followed from innovation may also be associated with environmental damage. Yet, integrating innovation and environmental goals can help to deal with tradeoffs between aims of growth and sustainability (Bossle et al 2016; Rennings, 2000), decouple economic growth from environmental damage (Smith et al, 2010) and therefore provide a win-win solution (UNEP, 2014).

In short, eco-innovation is an innovation that "results in a reduction of environmental impact, no matter whether or not that effect is intended" (OECD, 2010). Final report of the project "Measuring eco-innovation (Kemp und Pearson, 2008) stated: "Eco-innovation – – is the production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) to relevant alternatives". This definition emphasizes the impact on the environment and the comparison with previous solutions but does not require innovation to be necessarily new to the market – only that it is new to the user.

2.2 Innovation process – From invention into (eco-)innovation

Literature often refers to new ideas, inventions, simply as innovations. Yet there is a distinct difference between these terms (Cavalli, 2007), which already early innovation theorist Schumpeter (1942) addressed (Fagerberg, 2012). Invention creates a potential, but innovation process of preparing

and putting invention “on the market” and enabling actual wider scale use and diffusion, shapes it into an innovation (Nielsen, 2016).

In terms of eco-innovations, there are some distinctive features in the process of furthering the wider scale use and its impacts. Social acceptance has been recognized as a crucial factor in pursuing the positive environmental outcomes that the innovation could potentially bring (Stosic et al. 2016). Referring to studies concerning renewable energy innovations, Wüstenhagen et al. (2007) have introduced different dimensions of social acceptance (socio-political, community and market acceptance) which point to the multitude of the stakeholders of eco-innovations. As all these dimensions of acceptance are affecting the innovation process, the experienced fairness in cost-benefit or risk distribution (distributional justice) and decision-making process (procedural justice) concerning the eco-innovation, is essential (Gross, 2007).

Eco-innovations produce positive spillovers in both innovation and diffusion phases: knowledge externalities in research and innovation phases like all innovations and in addition, positive externalities related to environmental sustainability in the adoption and diffusion phases. These positive spillovers create a so-called double externality problem: actors who make decisions regarding eco-innovation activities or adoption of eco-innovations, don’t have sufficiently incentives to invest the amount that would (due to the positive externalities) be optimal for the society as a whole. (Rennings, 2000). Part of the market problem may also prices that do not always reflect negative externalities and possible distorting subsidies to unsustainable inputs or production (Ghisetti et al. 2015). Therefore, to fix these market failures and distorted competition between environmental and non-environmental innovation, the role of policy instruments, e.g. financial support is essential. (Rennings, 2000; del Río et a.l 2016; Ghisetti et al. 2015).

In case of gypsum amendment, this applies also to farmers’ interests. Potential reduction in phosphorus loading creates public goods. According to the economic theory, private actors’ interest to contribute into public goods is limited and their preference to invest in them is only to the point where their marginal private benefits are equal to marginal costs. To achieve the socially optimal level of use of a measure that reduces loading, financial support would be essential.

Because of the need for policy support, eg. regulatory and financial support, it is essential to evaluate eco-innovations to know what kind of innovations should be supported. (Stosic et al. 2016; del Río

et a.l 2016, Bossle et al. 2016). Furthermore, to ascertain the efficacy of policy instruments, it is important to identify drivers that increase the acceptance and adoption of environmentally beneficial practices (Pannell et al, 2020; Blackstock et al., 2010). Recognizing these drivers and determinants enables to design both the eco-innovation and the surrounding policy framework in order to enhance adoption and by that, environmental goals (Horbach et al, 2012).

As earlier innovation paradigma has underlined traditional producer perspective (Nielsen, 2016; Chesbrough, 2008) and the role of eg. research organizations as the only source of knowledge, these days potential future users of innovation are seen as valuable partners in knowledge co-production. Social, open and user innovation are partly overlapping concepts (Chalmers, 2012) of innovation that refer to collaborative forms of innovation process. They all challenge the traditional, top-down, linear approach to innovation and acknowledge the importance of stakeholder perspectives as well as different sources of information (Bock, 2012; Klievink & Janssen, 2014; Chesbrough, 2008) and enhance the acceptance and adoption of an innovation.

2.3 Social innovation as a platform for co-creation, knowledge sharing and discourse

Social innovation indicates to innovation as a social phenomenon (Klievink & Janssen, 2014) and points out the importance of surrounding society as a context that influences the development, diffusion and the use of innovations (Bock, 2012). “Social innovations’ central elements are interaction between people, and their organization in communities”. (Klievink & Janssen, 2014). A concept social innovation is ambigious and there is no sole or exclusive understanding of the term. (e.g. Bock, 2012). Definitions are often context related and attached to certain problems or cases Many social innovation projects contribute to social common goods. Also a citizen can be as initiator (Voorberg et al, 2015)).

Social innovation is also used describing social aspects of technological innovations (Klievink & Janssen, 2014; Pol & Ville, 2009). Schumpeter pointed out already in 1942, that social innovations are important in ensuring economic effectiveness of technological innovations (Moulaert et al, 2016, Schumpeter 1942). Social innovation projects can also create bonds between stakeholders that enable knowledge exchange and platform for communication and collaboration (Klievink & Janssen, 2014). This enables the use of wider and more effective scope of resources in designing the outcome.

The participation of end-users within innovation is seen increasingly important in literature (von Hippel, 2003; Chesbrough et al., 2006) Although separate concepts, both the whole open innovation paradigma and user innovation are based on notion that essential innovation knowledge is widely distributed and therefore collaboration outside organization enhances the innovation process by bringing in knowledge that might otherwise be difficult and costly to gather (Chesbrough, 2008, Hippel, 2003). Outside formal R&D activities, there are practitioners who are experts through own work or other involvement and experience in their field. They have gained practical expertise, implicit knowledge, which may be difficult to explicate and transfer as such directly to other parties (Baars, 2011; Sennett, 2008). Experienced practitioners also possess intuitive and experimental knowledge, which Polanyi (1966) has described as tacit knowledge. According to Polanyi (1966) tacit knowledge is essential part of technology in general. This kind of indefinable knowledge is difficult to transmit, since there isn't any explicit detailed description of it (Polanyi 1966, Baars, 2011).

In user innovation literature similar knowledge is part of what is called "sticky information" (von Hippel (1994). Innovating and solving problems requires information that is often "sticky", which complicates research and development. (von Hippel 2003). From a management point of view "sticky information" is difficult and costly to gather and transfer because of its implicit and tacit nature. (von Hippel 2003)) Using external sources outside organization in the innovation process, namely users, enables the use of "local" information. This knowledge that users or potential future users have "on site" is essential for the innovation process. (von Hippel 2003))

2.4 Conceptual framework

Today farmers meet increasing pressures to produce more efficiently and resulting in less environmental damage, "more and better from less'' (EIP-AGRI, 2014). Also, the EU's common agricultural policy (CAP) is becoming more market oriented and growingly emphasizes also environmental matters. (Läpple et al. 2015.) Gypsum amendment is, according to previous studies, a potential promising eco-innovation and an invention that requires(ed) large scale testing in order to convince and achieve acceptance from stakeholders and hence to become a successful new agricultural water protection measure. As for that, a pilot project SAVE was constructed to become a platform for further testing as well as discourse for all substantial parties.

Farmers contribution to the pilot project SAVE was crucial and they are one of the key stakeholders in the innovation process. They agreed to participate and allowed the gypsum spreading on their fields and hence made all the scientific research and testing of the method possible in the pilot area. In farmers' meetings they gave valuable knowledge of the area as well as their worriers, needs and the risks that they saw concerning the upcoming pilot and the method. The implementation of the gypsum spreading was carried out by them – either through contractors or by the farmers themselves. By answering the pilot questionnaires farmers delivered information about their experiences in the pilot and their observations and perceptions concerning gypsum as well as data about agricultural activities in their farms. All information gathered from them was an essential part of the research and design of the new measure and thereby communication that was delivered through the pilot to other key stakeholders. This knowledge has formed an essential part in enhancing the progress of the gypsum amendment to become an accepted part in the toolkit of agricultural water protection measures.

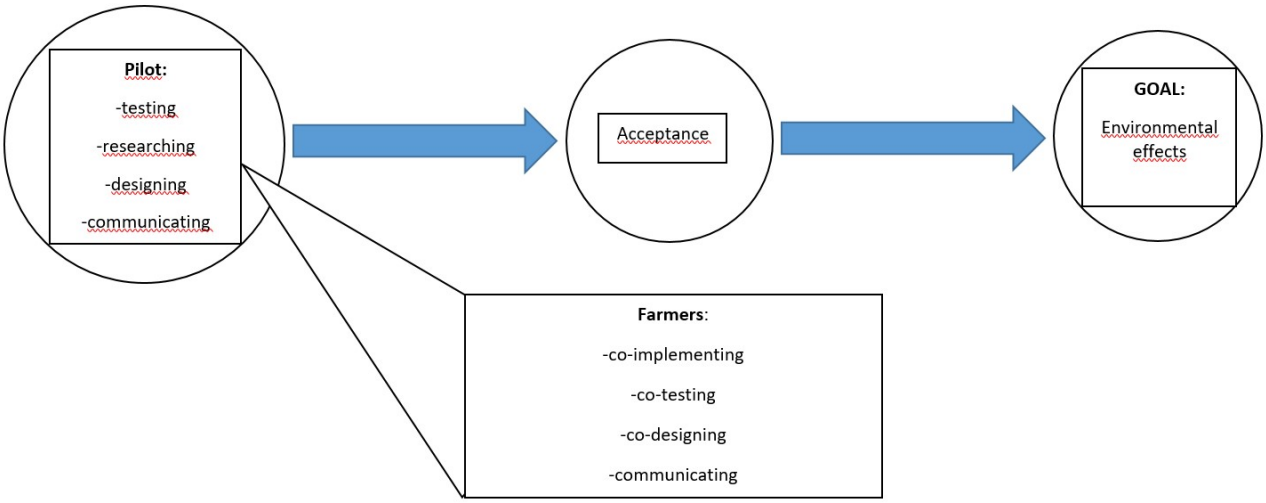

Figure 1 *Innovation process present in the pilot project: Building social acceptance through the pilot – Farmers as co-innovators*

Through this framework (Figure 2) I will study the drivers of farmers' contribution/participation in the pilot. The role of participating farmers was essential in implementing the pilot and co-producing the multiple outcomes that resulted from it. Farmers acted as co-creators of the pilot and co-innovators and adopters of the new measure. By reporting about their perceptions and experiences on the use of gypsum they also gave insight about farmers' perspective to other stakeholders.

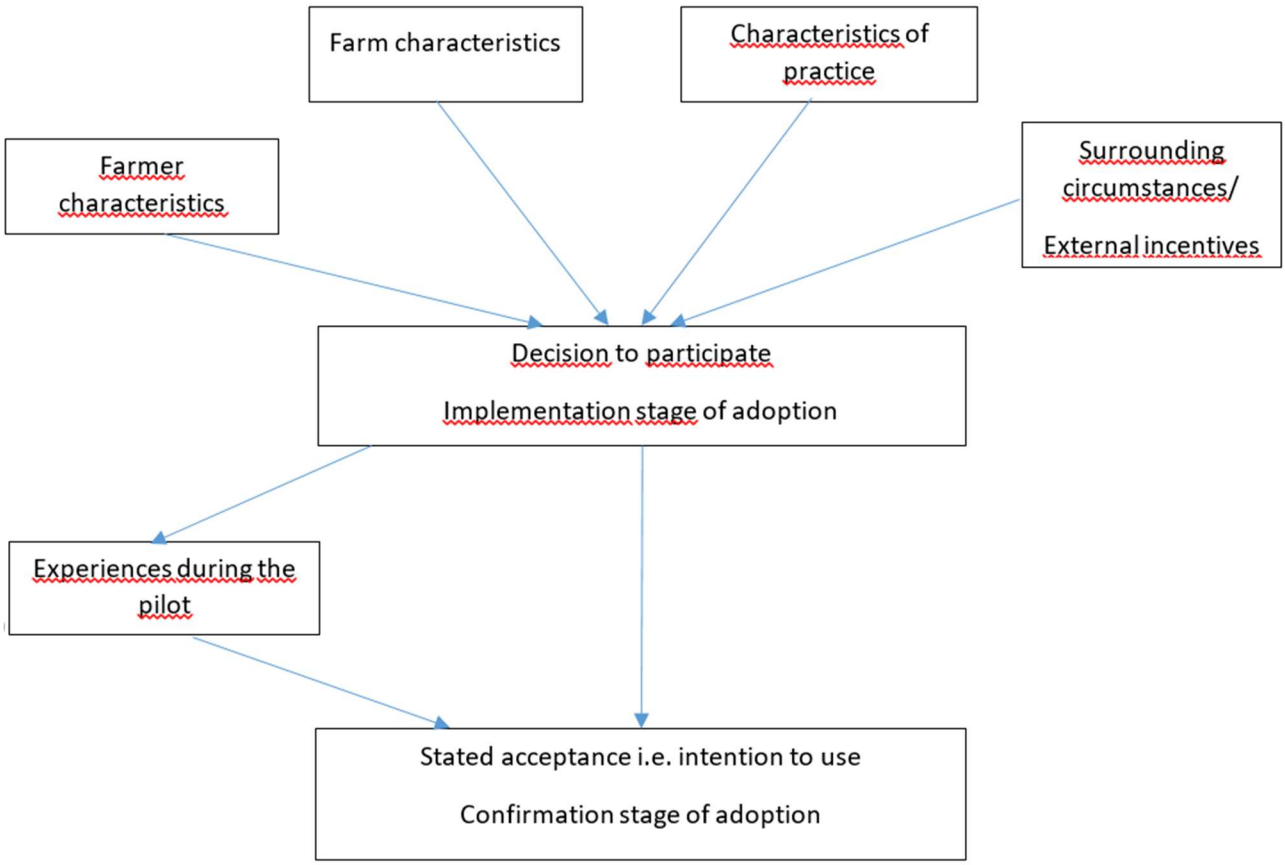

Figure 2. *Conceptual framework of drivers for farmers' contribution in the pilot*

Farmers participated in the pilot project as co-innovators and adopted the agricultural eco-innovation. Numerous studies about designing new agri-environmental measures have brought forth the importance of taking farmers' perspective into account in planning the measures. Examining drivers for participation, acceptance and adoption, "reasons for their decisions and behaviour" (Blackstock et al, 2010), "modeling participation" (Hynes, 2009) is therefore crucial in order to accomplish the potential positive environmental outcomes. As adoption of new agricultural measures is voluntary for farmers, the measures are taken up only in case farmers accept them (Vanslembrouck et al. 2002).

In this study, the effect of the following factors on participation and adoption are explored using the survey data and statistical methods: farmer characteristics (including farmer motivations and perceptions), characteristics of practice and farm and external incentives.

3. Literature review

This section presents the previous literature on the drivers for participation in co-innovation as well as drivers for adopting an eco-innovation.

3.1 Modelling farmers decisions

When adoption of new measures is voluntary for farmers, the measures are taken up only in case farmers accept them. Hence, also the pursued, potential objectives are linked to farmers decision making. (Espinosa-Goded, 2010; Vanslembrouck et al. 2002). Therefore, factors affecting the farmers choices concerning new agricultural measures have been studied and modeled in various ways, based on different theoretical frameworks. (Unay-Gailhard, 2016). Some studies (e.g. Home et al, 2014) base their analysis on the theory of planned behaviour, which is developed from the theory of reasoned action by Fishbein and Ajzen (1975) (Unay-Gailhard, 2016). According to the theory, farmers' behavioral intentions are related to their attitudes. Therefore, getting insight of farmers' attitudes and perceptions helps to predict the level of adoption of the measure in the future and also to design more successful agricultural measures. (Unay-Gailhard, 2016.)

According to the microeconomic theory, farmers aim to maximize their utility when making decisions about farming. Therefore, they weigh perceived costs and benefits (Vanslembrouck et al. 2002) as well as risks (Sattler & Nagel, 2010) when considering adopting a new agricultural measure. To better understand the economics behind farmers' decisions, different micro-economic utility models have been derived and tested. (e.g. Vanslembrouck et al. 2002, Chouinard, 2008). In the studies by e.g. Vanslembrouck et al. (2002) and Greiner & Gregg (2011, the notion of utility maximization includes broader perspective to utility than just financial goals. For example, social or psychological utility through adopting a new measure can act as a driver in farmers' decisions. (Vanslembrouck et al. 2002, Chouinard, 2008). In case farmers emphasize for example environmental or social goals, they may forgo some financial profits to meet these goals and get personal contentment from it. This kind of expanded utility framework may differ from seeking pure financial goals and yet be rational and consistent with the economic model. (Vanslembrouck et al. 2002, Chouinard, 2008)

3.2 Drivers

Some studies have also classified motivations to participate in co-creation into intrinsic (personally rewarding in itself) and extrinsic (earning a reward or to avoid punishment) ones (Lakhani and Wolf, 2005, stock et al,). Influencing factors of adoption of agri-environmental practices have been classified in different studies (Defrancesco et al 2008). According to literature, willingness to adopt a new agricultural measure is a function of farm and farmer characteristics (Sattler & Nagel, 2010; Vanslembrouck et al. 2002), characteristics of the practice (Greiner & Gregg, 2011; Sattler & Nagel, 2010; Vanslembrouck et al. 2002) and surrounding circumstances (Sattler & Nagel, 2010; Vanslembrouck et al. 2002).

There is also a growing attention on sociological, psychological and sociopsychological factors: How farmers diverse motives (Atari et al. 2009, Greiner & Gregg, 2011, Chouinard, 2008), attitudes (Sattler & Nagel, 2010; Maybery, 2005; Vanslembrouck et al. 2002), perceptions (Sattler & Nagel, 2010; Grener 2009; Vanslembrouck et al. 2002) and values (Maybery, 2005) influence their decisions concerning farming. The question of adoption (or participation in argi-environmental programs) is also not only about individual characteristics and/or how an individual adopter perceives an innovation: social factors and interaction with other stakeholders play a significant role in decision making. (Hasler et al, 2017; Defrancesco et al 2008: Vanslembrouck et al. 2002: Sattler & Nagel, 2010)

In different cases different characteristics may be emphasized (Vanslembrouck et al. 2002). Farm producers themselves are a heterogeneous group, also on the same land area (Defrancesco et al, 2008, Atari et al. 2009, Maybery, 2005, Defrancesco et al, 2008). As a group, their behavior towards different measures is divided and often ad hoc, depending on the case and situation in hand (Chouinard, 2008).

3.2.1 Farmer characteristics

Much of the literature researching influencing drivers has concentrated on socioeconomic and demographic factors of farmers and characteristics of farms (Greiner 2009, Defrancesco et al, 2008).

Socio-demographical characteristics

According to literature, farmers demographical characteristics influence their views on new measures, but the results of the way in which they affect are sometimes conflicting. Age has been found to be a significant variable, but the results are contradictory: in some studies, younger farmers are more inclined to take new measures while other studies have found older farmers to be more positive towards new measures (Vanslembrouck et al. 2002, Defrancesco et al, 2008). The same applies to experience with farming: results are incoherent (Atari et al. 2009). Education seems to increase adoption of a new agri-environmental measures in most studies, as it may further the understanding for the need of new methods (Defrancesco et al, 2008, Vanslembrouck et al. 2002), but also opposite results are found (Defrancesco et al, 2008). Literature on the effect of dependency on farming income is also conflicting (Defrancesco et al, 2008).

According to literature higher income relates positively with willingness to adopt new innovations in general (Rogers 1995) and also regarding new conservation practices (Atari et al. 2009). Also, earlier experience with agri-environmental measures mostly advances positive attitude towards new measures (Unay-Gailhard, 2016; Defrancesco et al, 2008), although not in all cases (Vanslembrouck et al. 2002). Large share of rented land seems to affect adoption of new measures usually negatively. Intention to continue farming does not necessarily indicate adoption either. (Defrancesco et al, 2008)

Personal characteristics, pre-existing views, earlier experiences, motivations, attitudes, and perceptions

Farmers are heterogenous individuals who have different personality traits, pre-existing values, attitudes (Maybery, 2005), self-identities (Home et al, 2014) norms and beliefs (Reimer et al, 2014), possible earlier experiences with conservation measures (Home et al, 2014) which affect their views, attitudes, motives and perceptions in the given situation with other factors (Maybery, 2005). Farmers awareness of the existing problem and how their actions are related to it may influence their decisions. The knowledge they have and the information they are given relates to their feelings of responsibility (Blackstock et al., 2010). “Perceived need for action” might stem from given information and act as a driver for seeing the new measure as a solution (Hasler et al, 2017). Also, if farmers experience e.g. psychological utility/benefit for e.g. altruistic environmental stewardship behaviour (emphasizing responsible use of resources and seeing farming as a way of life rather than just as a business) (Chouinard, 2008), knowledge about the problem precedes that. Moreover, trust in source of information is important (Blackstock et al., 2010). Different farmers also emphasize different sources and channels of information (Defrancesco et al, 2008).

3.2.2 Characteristics of practice and farm

The new measure itself may also impact either positively or negatively on farmers' income. Impacts on output and resource use (Vanslembrouck et al. 2002), possible agrological (dis)benefits (Reimer et al., 2014) and easiness of implementation (Defrancesco et al, 2008, Vanslembrouck et al. 2002) influence decision making. Earlier knowledge and familiarity of the method advances adoption (Atari et al. 2009) – perceived risks may hinder it (Greiner, 2009). Also, the expected environmental impacts and results as such and clearness of results concerning them may be important for farmers (Home et al, 2014; Defrancesco et al, 2008).

The policy surrounding the measure is important for farmers. Compensation of extra costs that the measure and its implementation cause lower the threshold for participation. (Defrancesco et al, 2008; Vanslembrouck et al. 2002). Uncertainty of continuation of the policy and payments (Sattler & Nagel, 2010) or complexity of the policy system (Reimer et al, 2014) may prevent participation. Overall transaction costs related to taking up the new measure (with information transfer, processing and administrative work) matters in farmers decisions (Espinosa-Goded et al. 2013)

Farm-specific characteristics have been suggested to be the primary drivers of sustainable behaviour associated with agri-environmental measure participation. (Unay-Gailhard, 2016) These are farm size and good soil quality (Pierpaoli et al, 2013), and business factors such as tenure (including the influence of landlords on the entry decision for leased land) (Defrancesco et al, 2008).

3.2.3 Social factors

According to literature, there may be several incentives to take part in the innovation process as co-innovator. One of them is that innovators feel they benefit from using the innovation they create or improve (Bin, 2013; von hippel 1988, Füller 2006; Hienerth, 2006 There may be direct economic benefits (Hienerth, 2006: Füller 2006), or benefits concerning eg. social recognition, career or reputational matters – personal or benefits eg. for the company (Bin, 2013 Nambisan et al. 2010; Franke and Shah, 2003; (Lakhani & von Hippel, 2003). Matters related to social capital are often important drivers (nielsen), for example building social relationships via participation (Bin, 2013), or feeling that helping others is important (Lakhani & von Hippel, 2003, franke &shah), even an obligation (Lakhani and Wolf, 2005; Nambisan et al. 2010) or way to reciprocate (Lakhani and Wolf, 2005) and by helping one can expect reciprocity (Lakhani & von Hippel, 2003, franke &shah). Also,

an opportunity to develope skills (Bin, 2013; Hienerth, 2006, 2013; Lakhani and Wolf, 2005; Füller 2006; Nambisan et al. 2010) or a feeling of having expertise in the matter (Lakhani & von Hippel, 2003) can act as an incentive. Simply, enjoyment of creating can be important for participants (franke et shah, Hienerth, 2006; von Hippel et al., 2012), or showing ideas for others (Füller 2006) as well as curiosity towards the matter in question (Füller 2006).

Farmers are part of their communities, and social capital (meaning norms and networks of the group and access to different resources that come along with beeing part of the group) matters to them and influence their decisions (Krom, 2017). Views of neighboring farmers (Defrancesco et al, 2008; Greiner & Gregg, 2011) industry associations (Greiner & Gregg, 2011, local non-farming community (Atari et al. 2009, Krom, 2017) and other stakeholders (Hasler et al, 2017; Defrancesco et al, 2008; Vanslembrouck et al. 2002) impact their decisions. All and all farmers perception of opinions and expectations of society (as a whole/at large) matters to them (Defrancesco et al, 2008, Hasler et al, 2017;, Greyner, 2009).

Reputational factors: appreciation and managing public perceptions

Farmers may also welcome potential appreciation for their decisions. Possibility for recognition for their actions may increase their interest in agri-environmental activities. (Krom, 2017; Hasler et al, 2017; Greiner & Gregg, 2011). Recognition may be rewarding for farmers themselves but can also be seen as a way to promote their livelihood – the whole farming sector (Atari et al. 2009). Farmers may seek to secure longer term viability for their business and a 'social license to produce' by showing interest for other stakeholders' expectations (Krom, 2017).

Fears of tightening regulations

Farmers may also be expecting, or even have fears for, further regulations and restrictions, and feel less powerful against upcoming changes. Therefore, complying and seeing opportunities in changes and new ways of doing things may be one way to deal with uncertainty (Hasler et al, 2017) On the other hand, social pressure and fears of potential mandatory changes may also have an opposite effect on some farmers and create opposition towards new measures (Defrancesco et al, 2008). Also views of what is seen as good farming or good for the environment can be at odds with each other (Krom, 2017)

Relations to other stakeholders

Relationship with initiating parties and other stakeholders involved in the project is significant in many ways. Trust in them and the given information concerning the measure influences farmers' decisions (Blackstock et al., 2010; Defrancesco et al, 2008.). In collaborative programs, successful interaction and communication before the participation decision, social networks, mutual social learning and other aspects of social capital, lower the perceived transaction costs that cooperation and the new measure might generate (krom, Blackstock et al., 2010).

4. Material and methods

This study represents quantitative research and relies on the data gathered from farmers working in the pilot study area through three subsequent questionnaires between December 2016 and January 2019.

4.1 Data collection

Farmers in the study area of the project SAVE belonged to three groups according to the location of their farm and whether they participated in the pilot or not:

- Pilot farmers who had fields treated with gypsum in the area
- Local farmers who had fields in the "gypsum area", but didn't have any fields treated with gypsum
- Farmers who had fields in the control area, upstream from the gypsum treatment area.

The pilot study area (see https://blogs.helsinki.fi/save-kipsihanke/the-pilot-area/?lang=en) consists of two areas: the "gypsum area" where the fields treated with gypsum lie and the control area. Within the "gypsum area" there are fields treated with gypsum (51%) and fields without gypsum amendment. In addition, two farmers in the neighbouring area, but outside of the catchment basin, participated in the pilot.

The data were collected mainly through online platform called Surveypal. Earlier contacts at the start of the pilot had revealed, that some farmers did not have access to internet. Therefore, some of the

questionnaires was sent as mail-out–mail-reply surveys. As the first questionnaire was tested a couple of times by two farmers via phone call, their answers were collected during the conversation to save their time.

The first questionnaires were sent in mid-December 2016, few months after spreading the gypsum application. After the first invitation, the farmers received a reminder via email and after that a text message, but these contacts did not have much effect. After that a first round of reminder phone calls was made, and more responses started building up. Finally, the second call round, and in some cases third or even fourth round, resulted in sufficient response rate. During the next years, only those who had responded to the previous questionnaire were contacted.

The first survey, sent to 55 participants in 2016, resulted in 48 responses, corresponding to 87% response rate. In order to gather a panel data, the second and third surveys targeted the respondents of previous survey(s). After few dropouts and one response that became unintentionally destroyed due to a technical problem in 2017, the final number of respondents in the panel analysis (including three answers per respondent) was 43, corresponding to a 78% response rate of the total sampled population. In the third survey, 9% of responses was obtained by mail while the percentage in the first survey was 15%.

4.2 Questionnaires

To target all farmers in the study area, three types of questionnaires were created. All of them were repeated twice in the next two years – and regarding the survey directed to the pilot farmers, with some changes made each year. In the first year, all surveys also contained questions about demographic factors of farmers and characteristics of their farms.

Each questionnaire started with questions concerning the fields and farm work in the study area. These questions were asked to provide data for the calculations concerning the effects of gypsum amendment on phosphorus loading. In addition, all questionnaires contained attitudinal questions concerning the use of gypsum and the pilot. In the end of all questionnaires each year there was a possibility to give feedback and bring up thoughts in a form of an open-ended question. In the first

year, all farmers were also asked whether they had been aware of gypsum as a water protection measure before the pilot.

In the questionnaire directed to the pilot farmers, the other questions handled specific subjects which followed the course of the pilot. In the first year the survey focused on motives for participating the pilot and experiences, observations, thoughts and suggestions concerning the logistics of handling and spreading the gypsum. In the second and third year, the focus was on the observations of the effects of gypsum on fields, yields and surrounding water systems.

The questionnaires were developed cooperatively within the pilot work group, altogether by 4–6 persons. From early scratch on, assistance and feedback were asked from a few other researchers in the faculty as well as the steering group of the project. In addition, the earlier mentioned two farmers gave their views on the survey, the other one twice. The development process was iterative: in between each group meeting and feedback session, changes and additions were made to the survey. Questions concerning farmers motivations to participate in the pilot came mainly from user innovation and agri-innovation literature. The questions about risks that farmers saw originated from earlier farmer meetings, where farmers had brought up their concerns about the method and the pilot. Attitudinal questions and questions about perceptions and views towards gypsum and the pilot initiative were created by the research group. Questions concerning farmers demographic factors originated from earlier farmer studies.

The first questionnaire was sent to farmers a few months after the gypsum spreading that took place in summer and autumn 2016. The aim of the questionnaires was to collect information for the research in the pilot and for different stakeholders about:

- farm activities in the pilot area to support the calculations on the phosphorus load reductions
- farmers experiences on logistics and operability of gypsum spreading
- farmers observations on the effects of gypsum on their fields
- farmers perceptions, motivations, attitudes and acceptance towards the use of gypsum as a water protection measure and the pilot
- farmers views and suggestions on how the measure and its design should be developed and improved

This study utilizes the last four of these listed parts of the survey: data about farmers, their motivations, attitudes, perceptions, observations and experiences. It uses mainly the first year's survey data, which contained the highest response rate. In addition, the perceptions concerning the gypsum's effect on yield and fields were included from the second and third year survey data.

4.3 Statistical methods

Factor analysis is a statistical method used to summarize and compress information from research data by reducing a larger set of variables into fewer factors and to identify underlying dimensions from them. It is a common tool in social sciences and many other disciplines, e.g., in psychology and marketing, in which research data may contain a large set of scores, for example perceptions or attitudes towards something. By using factor analysis, it may be possible to describe data by grouping variables with each other and to find underlying structures from the results. Literature on factor analysis recommends generally that the required sample size should either be at least 100 participants, or five or even 10 times larger than the number of measured variables e.g., statements. Yet, these guidelines are not based on strong theoretical or empirical foundations and have also been questioned. (Fabrigar & Wegener, 2012.)

There are different types of factor analysis and different methods that can be used to conduct it. The two main types are confirmatory and exploratory factor analysis. If there are expectations of a certain kind of factor formation based on theory and/or earlier literature, the confirmatory approach can be used to test the hypothesis. In order to find the factor analysis useful for the data, Kaiser-Meyer-Olkin measure needs to be at least 0.5 and Bartlett sig less than 0.05. (IBM Knowledge center 2020) When there are no clear assumptions of how the variables will construct and the aim is to identify conceptual dimensions of the data, exploratory analysis will be a useful tool. Exploratory analysis may also be used in the development of measurement instruments at the early phases of the research. (Fabrigar & Wegener, 2012.)

The crosstabs, Chi_Square tests and McNemer tests were used in order to test the differences between groups.

To model the factors affecting the acceptance of gypsum, binary logistic regression model is appropriate when the response variable is dichotomous (Yes/No to the question whether one would use gypsum). The answers were converted into dummy variables (1 = Yes, 0 = No). The regression factor scores were computed for each factor in SPSS to be able to use them in the regression analysis.

One option would have been to use mean item scores, which are averaged from the original items and have a similar scale as the original items (1–7), unlike factor score values which range from approximately -3.0 to +3.0. However, for example DiStefano et al. (2009) recommend using factor scores to maximize the validity of estimates.

5. Results

5.1 Reasons not to participate in the pilot

According to the project report (Project SAVE webpage, 2017) the main restriction for not to participate was that farmers' fields in the area were unsuitable (organic farming, grass fields, fields too small or too difficult to reach, or deficiency of magnesium or potassium) for the pilot (24). Second largest reason was that the farmer had just retired from farming or was planning to (9). Some farmers were not reached at all (6). 15 farmers had some other reasons: some had problems with the project schedule or were not interested or changed their mind about participation for some reason.

In the questionnaire aimed to the non-participating farmers in the pilot area, farmers were asked to assess possible reasons for their non-participation. To the question for "Why are you not taking part in the pilot?" the following results were given (Table 1). Number of respondents and percentages represent the clearly positive answers to the statements (5–7) on a Likert scale 1–7.

Table 1. *Reasons for not to take part in the pilot according to the questionnaire. Number of respondents and percentages represent the clearly positive answers (5–7) to the statements on a Likert scale 1–7 (1 = "not at all important" to 7 = "extremely important).*

Reasons for not to take part in the pilot

	Respondents	**Percentage**
I don't have suitable field areas.	10/27	37%
I rather wait for others to experiment first.	7/27	25,9%
I doubt whether the measure will work.	6/27	22,2%
There wouldn't be any gain for me to participate in the pilot.	3/27	11,1%
Not interested.	2/27	7,4%
My neighbours are not taking part.	0/27	0
Valid	24/27	88,9%
Missing	3/27	11,1%

According to the comparison between participating and non-participating farmers in the pilot area (unpublished report 2017), the following differences were found to be statistically significant ($p < 0,1$): The pilot participants are on average owners of larger farms and also leasing larger areas of fields. This may have also increased the probability of having suitable fields for gypsum. Non-participating farmers are somewhat older and gave their answers to the questionnaire more likely by mail, which may have been linked to the age factor. They also had had less agricultural education.
Interestingly, there didn't seem to any statistically significant differences regarding the different statements concerning the gypsum amendment, the pilot or general perceptions concerning agriculture. The only exception to that was, that the pilot farmers stated that they were slightly more concerned for the future funding of traditional conservation methods and were also more keen to have information updates from the pilot.

5.2 Farmer motivations – reasons to participate

Over 90% of the pilot farmers stated clearly that they made the decision to participate in the pilot independently. In the first questionnaire they were asked to assess the importance of reasons for them to participate in the project. Figure 3 shows the results of the question. Range for assessing was a Likert scale 1–7, smallest number meaning "Not at all important" and the largest "'Extremely important".

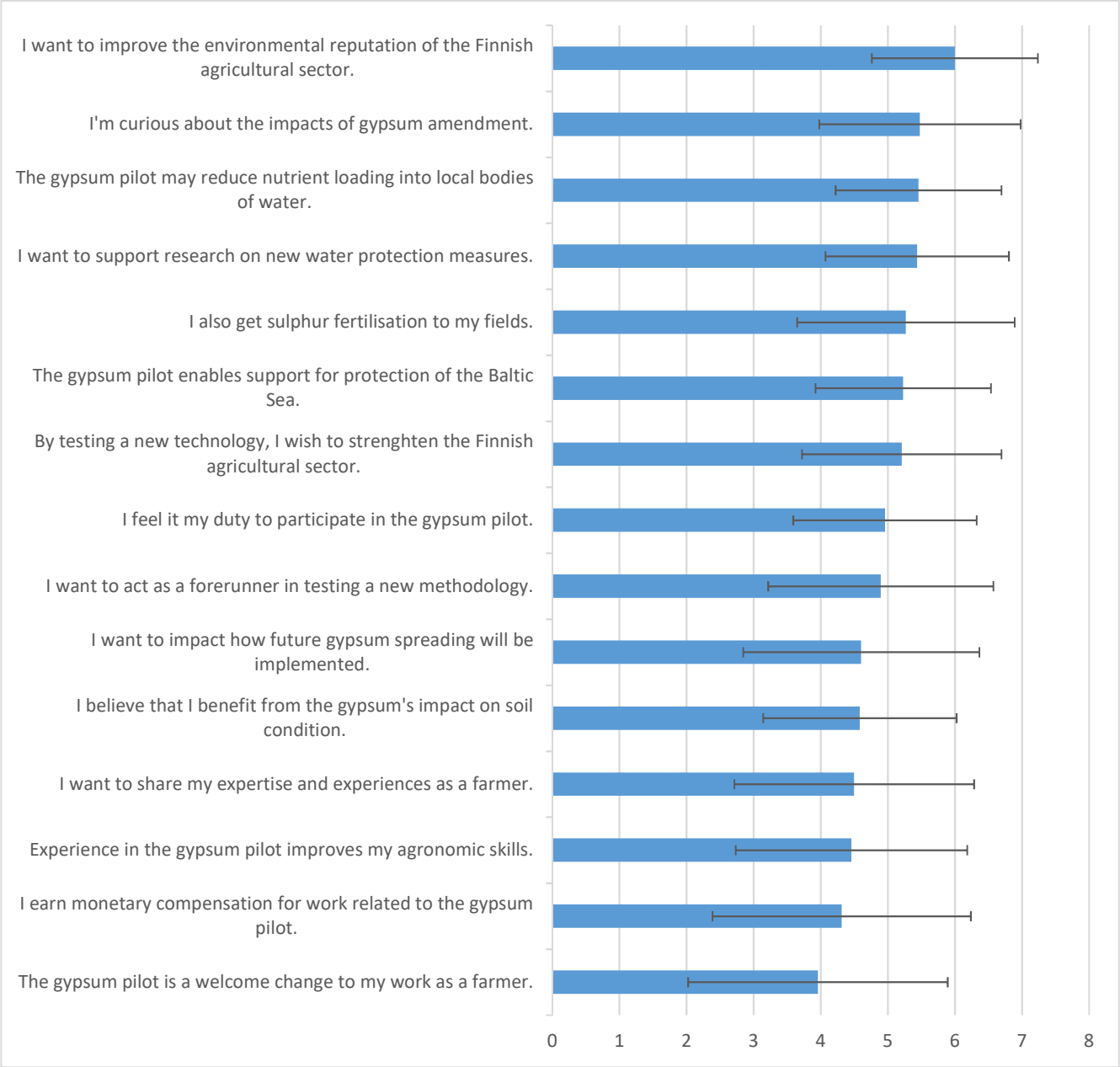

Figure 3. *Importance of reasons to participate in the pilot. Items are sorted by mean importance; error bars show the standard deviation. Rating scale from 1 = "not at all important" to 7 = "extremely important".*

To compress information of these results, reduce the dimensionality of the answers and to find meaningful new factor variables of the data, exploratory factor analysis was performed. In addition to "reasons to participate" questions, four other items were added to the set:

- I often try new agricultural methods.
- Pilot has enhanced social cohesion among participating farmers.
- I am proud of being part of the project.
- I find it rewarding to be able to share my ideas.

This group of statements were originally created to reach the variety of different motivational aspects, similarly to a study investigating why consumers engage in new product developments (Füller 2006), but ended up to the next set of items during the development of the questionnaire.

First, all available methods both for factor extraction and rotations were tested in SPSS. Extraction was based on eigenvalue (greater than one, e.g. Kaiser criterion). The best fit was found with extraction method principal component analysis (PCA) and orthogonal rotation method varimax. With other options the factor composition was less consistent, and communalities or/and variance percent were lower. According to general guidelines, the sample size (48) for conducting factor analysis was very small, even too small. Yet the model was found to be fit: the results were reasonable, communalities of the measured variables were high (average 0,675) and at least 3 statements were found to be assigned on each factor. The extracted factors explained nearly 71% of the variability in the original 19 variables. Also, the results of KMO (0,826) and Bartlett's test (significance level 0,000) indicated that factor analysis might be a useful and that variables were suitable for structure detection.

Four factors were found to represent the dimensions of farmers' motivations in participating in the pilot. They were named to represent the statements that the factors were composed of (Table 2).

Table 2. *Extracted factors, which represent the dimensions of farmers' motivations in participating in the pilot.*

	Conservation and environmental reputation motivation	Influencing as a practicing farmer expert motivation	Agricultural and financial benefits motivation	Social motivation
Conservation and environmental reputation motivation				
The gypsum pilot may reduce nutrient loading into local bodies of water.	**0,841**			
The gypsum pilot enables support for protection of the Baltic Sea.	**0,793**			
I'm curious about the impacts of gypsum amendment.	**0,723**	0,44		
I want to improve the environmental reputation of the Finnish agricultural sector.	**0,637**	0,427		0,355
By testing a new technology, I wish to strenghten the Finnish agricultural sector.	**0,593**		0,336	0,434

I am proud of being part of the project.	**0,578**			0,414
Influencing as a practicing farmer expert motivation				
I want to impact how future gypsum spreading will be implemented.		**0,792**		
I often try new agricultural methods.		**0,724**		
I find it rewarding to be able to share my ideas.		**0,647**		0,323
I want to act as a forerunner in testing a new methodology.	0,507	**0,647**		
I want to share my expertise and experiences as a farmer.		**0,631**		0,51
The gypsum pilot is a welcome change to my work as a farmer.		**0,582**	0,477	
Agricultural and financial benefits motivation				
I believe that I benefit from the gypsum's impact on soil condition.			**0,848**	
I also get sulphur fertilisation to my fields.			**0,811**	
Experience in the gypsum pilot improves my agronomic skills.	0,437	0,52	**0,54**	
I earn monetary compensation for work related to the gypsum pilot.	-0,358		**0,502**	0,346
Social motivation				
I want to support research on new water protection measures.	0,441	0,318		**0,712**
Pilot has enhanced social cohesion among participating farmers.	0,402			**0,635**
I feel it my duty to participate in the gypsum pilot.			0,476	**0,594**
Composite mean importance of the factor	**5,31**	**4,34**	**4.66**	**4,99**
Variance explained (%)	**22,5**	**19,9**	**15,4**	**13,1**

Note: *Only the factor loadings over 0.3 are reported in the table for clarity.*

5.3 Attitudes, concerns and feedback

Farmers were asked also to answer various attitudinal statements concerning the new measure, the pilot and their farming. Answers to them are shown in Figure 4. The presentation mode (percentages of positive responses) was chosen to express the affirmative attitudes towards the statements.

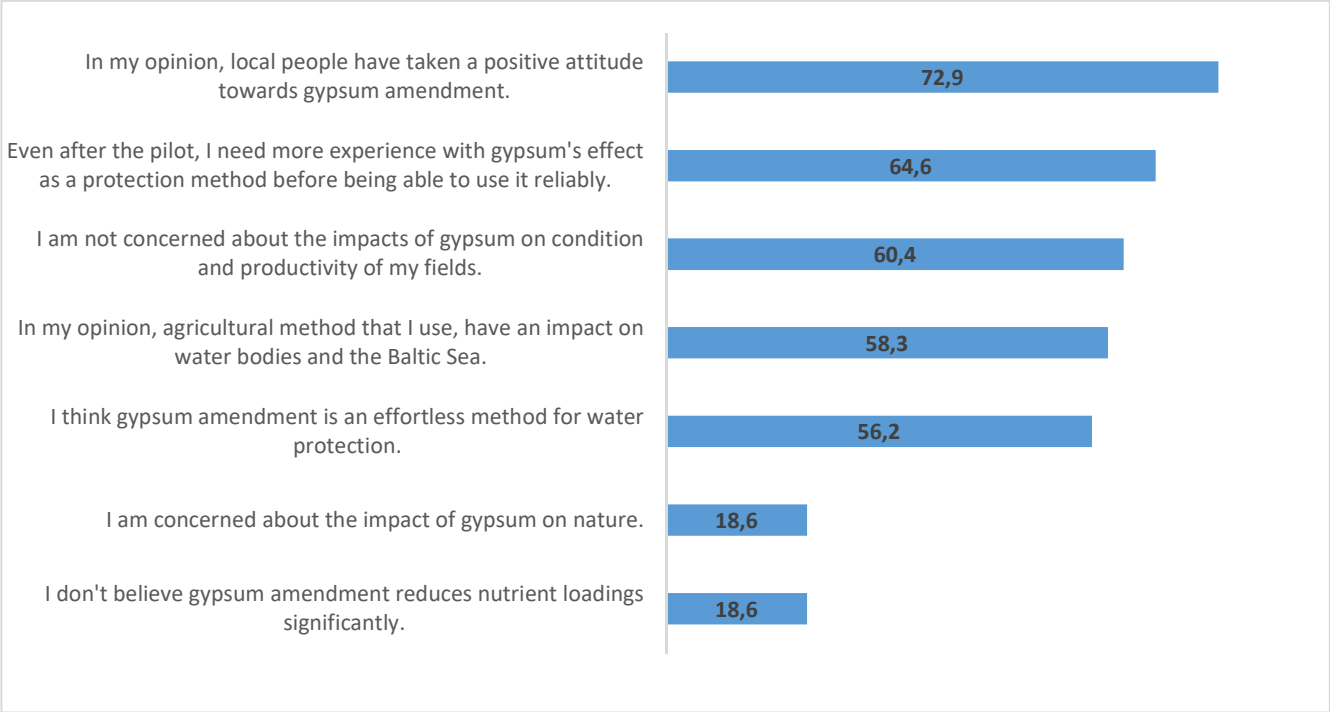

Figure 4. *Attitudinal statements sorted by positive responses (5–7) on a Likert scale 1–7 (1 = "Completely disagree" to 7 = "Completely agree").*

Farmers were also asked about their worries concerning the measure and the pilot. The represented worries (Figure 5) were based on discussions with farmers in the earlier farmer meetings.

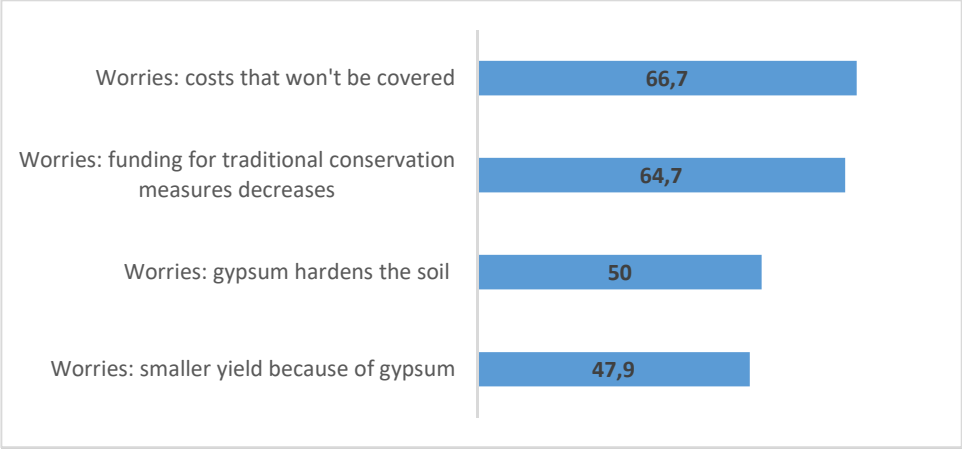

Figure 5. *Farmers' worries: responses to the question "How much do the following matters worry you?". The numbers represent percentages of the positive answers (5–7) to the question on a Likert scale 1–7 (1 = "Not at all" to 7 = "Very much").*

To get feedback concerning the pilot initiators and their acts, farmers were asked to assess the following statements (Figure 6).

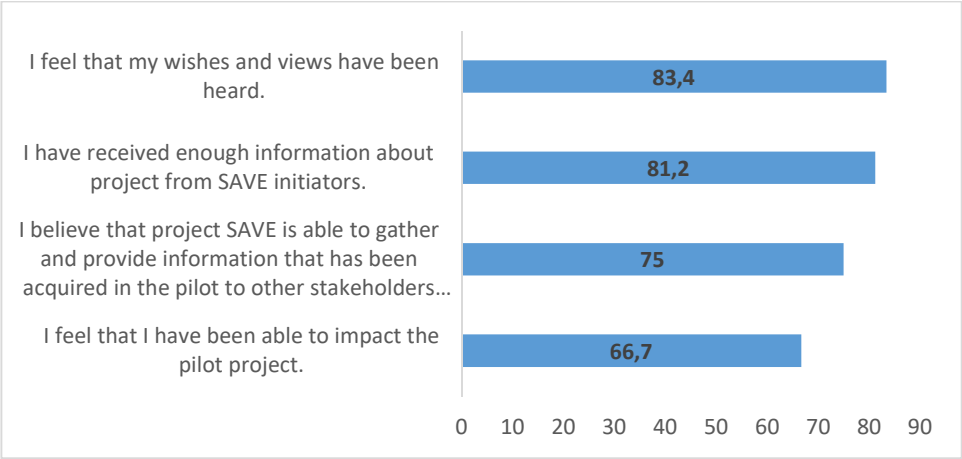

Figure 6. *Farmers' answers to different statements concerning feedback to pilot initiators. The numbers show positive responses (5–7) on a Likert scale 1–7 (1 = "Completely disagree" to 7 = "Completely agree").*

5.4 Pilot farmers' acceptance towards the new measure

To rate the acceptance towards the gypsum amendment as a potential new measure, participating farmers were asked in all three yearly questionnaires: "Would you use gypsum, if it were part of the compensation regime (and possible in your fields)?" and "Would you recommend gypsum to farmers elsewhere in Finland?". In the first year, the positive answers to these questions were 78,7% to "Would you use…" and 70,2% to "Would you recommend…" (N = 48). After the last questionnaire, the development between the answers each year was tested by McNemar test to find out if there were statistically significant differences between the paired yearly answers from the pilot farmers who answered all three questionnaires. No statistically significant differences were found between the years (N = 42) $p > 0,05$.

Table 3. *The shares of positive answers to the statements reflecting the acceptance towards the new measure (pilot farmers who completed all three questionnaires).*

	2016	2017	2018
Would you use gypsum if it were part of the agri-environmental scheme (and possible in your fields)?	76,2 %	66,7 %	76,2 %
Would you recommend gypsum to farmers elsewhere in Finland?	69,0 %	73,8 %	69,0 %
Valid	41	41	41
Missing	1	1	1

Farmer motivations

In order to explore the possible relationship between the extracted factors that represent the dimensions of farmers' participation motivations and the stated acceptance of the new method, a binary logistic regression was carried out in SPSS. The positive answers to the question "I would use gypsum…", from the first survey (2016–2017) were chosen to represent acceptance, as they reflect the rate of adoption in means of Rogers' adoption theory (Rogers, 1983), and the last stage of the adoption process which Rogers (1983) called the confirmation stage. The aim was to find whether farmers' placement on the motivation factors (factor score) could predict their stated acceptance of gypsum amendment, the intention to use it in the future. The results of the regression are shown in Table 4.

Table 4. *Results of the binary logistic regression testing the relation between the stated acceptance ("I would use gypsum…") and different motivational variables.*

Variables in the Equation

	B	**S.E.**	**Sig.**	**Exp(B)**
REGR factor scores for Conservation and environmental reputation motivation	**0,834**	0,428	**0,051***	**2,303**
REGR factor scores for Influencing as a practicing farmer expert motivation	0,247	0,489	0,613	1,281
REGR factor scores for Agricultural and financial benefits motivation	0,635	0,443	0,152	1,886
REGR factor scores for Social motivation	**1,253**	0,489	**0,01****	**3,501**
Constant	1,912	0,556	0,001	6,765

Note. The significance of the coefficients was determined by the Wald test. Note * stands for p-value less than 0.1 and note ** for p-value less than 0,05

The results show that there is a positive relation between the response variable ("Would use…") and two explanatory variables (Social motivation factor and Conservation and environmental reputation motivation factor). Significance values (0,01 < 0,05 and 0,051 < 0,1) show strong or fairly strong evidence against the null hypothesis, that these factors are not associated with stated acceptance.

According to the B value (1,253) of the Social motivation factor, every extra unit increase in this variable (controlling all the other variables in the model) increases the logit or estimated log-odds of the stated acceptance by 1,253 units. The same relationship can also be expressed in terms of odds

ratio (Exp(B) value 3,501), which means that every unit increase in Social motivation variable while controlling other variables, multiplies the odds of acceptance of the new measure by 3,5. Similarly, B and Exp(B) values of Conservation and environmental reputation motivation show that every extra unit increase in this variable increases estimated log-odds of the stated acceptance by 0,834 units and multiplies the odds of stated acceptance by 2,3. The significance values of other motivation variables are higher than any conventional chosen significance level, which means that there is no evidence against the null hypothesis (H_0). This means that there is not enough evidence to suggest a relation between the response variable and these variables. To note is that when the factors were tested one by one, separately, the results were parallel: same variables (Social motivation factor and Conservation and environmental reputation motivation factor) were found to have a relation with stated acceptance and to increase it.

Attitudes

Next, the effect of farmers' attitudes, concerns and feedback for the SAVE project on the acceptance (i.e. intention to use gypsum) from the first year (2016–2017) survey were explored. When analyzing all attitudinal statements together (Table 5), the perception that the local people's opinion is positive and the perceived easiness of the gypsum treatment of fields had a positive effect.

Table 5. *Results of the binary logistic regression testing the relation between acceptance of stated acceptance ("I would use gypsum…") and different attitudinal statements, when tested together in the same model.*

Variables in the Equation

	B	S.E.	Sig.	Exp(B)
In my opinion, local people have taken a positive attitude towards gypsum amendment.	1,09	0,626	**0,082***	2,974
I don't believe gypsum amendment reduces nutrient loadings significantly.	-0,164	0,581	0,777	0,848
I am concerned about the impact of gypsum on nature.	-0,671	0,522	0,199	0,511
In my opinion, agricultural method that I use, have an impact on water bodies and the Baltic Sea.	-0,294	0,549	0,593	0,745
I am not concerned about the impacts of gypsum on condition and productivity of my fields.	0,258	0,56	0,645	1,294
I think gypsum amendment is an effortless method for water protection.	0,969	0,487	**0,047****	2,635

Even after the pilot, I need more experience with gypsum's effect as a protection method before being able to use it reliably.	-0,023	0,562	0,967	0,977
Constant	-4,614	5,463	0,398	0,01

Note. The significance of the coefficients was determined by the Wald test. Note * stands for p-value less than 0.1 and note ** for p-value less than 0,05

In addition to these, when testing these attitudinal statements separately from the first year (2016–2017) survey (Table 6), the lack of concern about the impacts of gypsum on condition and productivity of fields increased the acceptance. Some farmers (18,6% in figure 4.) had concerns about gypsums' effect on surrounding nature, and this seemed to decrease the probability of acceptance towards gypsum, when the statements were tested separately (Table 6).

Table 6. *Results of the binary logistic regression testing the relation between acceptance of stated acceptance ("I would use gypsum…") and different attitudinal statements, when tested separately.*

Variables in the Equation

	B	S.E.	Sig.	Exp(B)
In my opinion, local people have taken a positive attitude towards gypsum amendment.	1,168	0,398	**0,003****	3,216
I don't believe gypsum amendment reduces nutrient loadings significantly.	-0,384	0,235	0,102	0,681
I am concerned about the impact of gypsum on nature.	-0,715	0,282	**0,011****	0,489
In my opinion, agricultural method that I use, have an impact on water bodies and the Baltic Sea.	0,364	0,286	0,204	1,439
I am not concerned about the impacts of gypsum on condition and productivity of my fields.	0,726	0,27	**0,007****	2,068
I think gypsum amendment is an effortless method for water protection.	0,952	0,312	**0,002****	2,59

Note. The significance of the coefficients was determined by the Wald test. Note * stands for p-value less than 0.1 and note ** for p-value less than 0,05

Concerns and feedback

None of the worries had a statistically significant impact on the acceptance, neither when tested all in the same model (Table 7) nor when tested separately.

Table 7. *Results of the binary logistic regression testing the relation between acceptance of stated acceptance ("I would use gypsum…") and different attitudinal statements on worries, when tested together in the same model.*

Variables in the Equation

	B	S.E.	Sig.	Exp(B)
Worries: costs that won't be covered	0,267	0,242	0,27	1,306
Worries: smaller yield because of gypsum	-0,385	0,398	0,333	0,68
Worries: gypsum hardens the soil	-0,053	0,363	0,883	0,948
Worries: funding for traditional conservation measures decreases	0,034	0,274	0,903	1,034
Constant	1,777	1,517	0,242	5,911

Note. The significance of the coefficients was determined by the Wald test.

Regarding the feedback to the SAVE project, none of the statements was statistically significant in the model (Table 8), when they were tested as a group. When tested one by one separately, the following statements did have a positive effect on the stated intention to participate:

- I have received enough information about project from SAVE initiators.
- I feel that my wishes and views have been heard.
- I believe that project SAVE is able to gather and provide information that has been acquired in the pilot to other stakeholders in Finland.

Table 8. *Results of the binary logistic regression testing the relation between acceptance of stated acceptance ("I would use gypsum…") and feedback statements, when tested together in the same model.*

Variables in the Equation

	B	S.E.	Sig.	Exp(B)
I have received enough information about project from SAVE initiators.	0,289	0,31	0,351	1,335
I feel that my wishes and views have been heard.	0,626	0,47	0,182	1,871
I feel that I have been able to impact the pilot project.	-0,068	0,429	0,875	0,935

I believe that project SAVE is able to gather and provide information that has been acquired in the pilot to other stakeholders in Finland.	0,515	0,392	0,189	1,673
Constant	-5,872	2,756	0,033	0,003

Note. The significance of the coefficients was determined by the Wald test.

Farmer and farm characteristics

One third (35,4%) of the pilot farmers heard about gypsum as a water protection measure for the first time through the pilot. To examine whether there was association between the pre-existing awareness (or lack of it) of gypsum as a water protection measure and the stated acceptance ("I would use gypsum…"), a cross-tabulation was performed. The results seen in Table 8. The Pearson Chi-Square test showed that there was no statistically significant relation between the variables, X^2 (1, N = 48) = 1,12, p > 0,05.

Table 8. *Results of cross-tabulation testing the relation between acceptance of stated acceptance ("I would use gypsum…") and earlier knowledge concerning gypsum as a water protection measure.*

			"Would you use gypsum…?"_Recoded		Total
			0	**1**	
Had at least heard or read about gypsum	**0**	Count	2	14	16
		% within Had at least heard or read about gypsum	12,50 %	87,50 %	100,00 %
	1	Count	8	23	31
		% within Had at least heard or read about gypsum	25,80 %	74,20 %	100,00 %
Total		Count	10	37	47
		% within Had at least heard or read about gypsum	21,30 %	78,70 %	100,00 %

Note. The significance of the coefficients was determined by the Pearson Chi-Square test (p 0,457 > 0,05)

Moreover, no statistically significant relation to the intended use of gypsum was found with respect to the following characteristics of the farmer and the farm, using the answers from the first questionnaire (2016–2017):

- field size in the pilot area (hectares), owned and leased
- total field size (hectares), owned and leased
- intention to continue farming (to note is that part of the farmers who intend to quit farming may not have participated in the pilot), all categories separately or at least six years
- the share of agricultural income (all four categories separately, over/under 50%)
- age classes (2 and 4 categories)
- education categories (grade by grade division to two classes)
- experience in performing agriculture (over / under 29 years, the division based on mean and median)
- agricultural education (some education or not)

However, a significant relation to the intended use of gypsum was found with the participation in the current agri-environmental payment (91% of the respondents participate in the current agri-environmental scheme).

Experiences in the pilot

Regarding the experiences on gypsum pilot, in general farmers did not face significant problems in the delivery and spreading of gypsum. The experiences, measured with the following aspects, also did not affect the acceptance statistically significantly:

- whether gypsum was spread by farmer himself or by an entrepreneur
- having encountered problems (separate cross tabs)
- having encountered problems (mean)

After the first and the second year of the gypsum spreading, farmers were asked whether they had noticed any differences on yield or soils. None of the farmers had experienced any negative effect on yield – neither on soils. Some farmers had noticed improvement on yield: 22% one year after gypsum spreading and 12% two years after. Part of the farmers had perceived improvement of soil: 37% one year after gypsum spreading and 28% two years after. The cross-tabulation showed that both of these perceptions had a statistically significant relation (enhanced the odds) with the stated acceptance i.e. intention to use answers of the same year (2017–2018 and 2018–2019).

6. Discussion and conclusions

The aim of this thesis was to study the drivers that affected farmers' contribution to the innovation process of a new agricultural water protection measure, the gypsum amendment of fields. Farmers participated in the gypsum pilot and acted as co-innovators by enabling the pilot and sharing their practitioner knowledge, experiences and perceptions during the pilot.

The research questions were:

- Which factors affected farmers' decision to participate in the pilot?
- Which factors affected farmers' acceptance towards the measure?

Drivers for participation in the pilot

According to the project report (Project SAVE webpage, 2017) the main barrier for participation was unsuitable fields. Farmers' answers to the survey also confirmed that. This finding, farm-specific characteristics as primary drivers, is parallel with conclusions of Unay-Gailhard & Bojnec (2016) regarding participation to agri-environmental measures.

In addition, to study the drivers that affected farmers' participation, a comparison was made between the participants and non-participants in the pilot area. Participants were on average somewhat younger, owners of larger farms and had more often agricultural education. Literature concerning the significance of demographic factors in adoption and participation in agri-environmental or conservation measures is conflicting, depending on the cases in question. Surprisingly, no statistically significant differences were found regarding perception and attitudes towards the new measure or the pilot. This seems to confirm that, while both groups were heterogeneous, differences in farmers' views were not the most common decisive issue in participation decision. This might be related to active recruitment of farmers, involvement of local farmer organization and advisory service as well as open discussion and interaction between farmers, initiators and other stakeholders.

The participating farmers were asked to assess the importance of various reasons to participate in the gypsum pilot. The highest rated single statement of all (by both mean importance and percentage of positive answers) was "I want to improve the environmental reputation of the Finnish agricultural sector". This implies that farmers are well aware of the pressures they face concerning the environmental matters. Importance of social factors including reputational matters are important

drivers regarding sustainable agricultural eco-innovations (Hasler et al. 2017) and agri-environmental schemes and programs (Krom, 2017; Greiner & Gregg, 2011, Atari et al. 2009) as well as eco-innovations in general (e.g. Bossle et al. 2016). The second highest rated statement was "I'm curious about the impacts of gypsum amendment". This suggests that farmers are interested in how and whether gypsum works, possibly both environmental and agricultural point of view. The following six highest rated motives (with the exception of the sulphur fertilization as a side benefit) related to environmental benefits and wishes to support both research and farmers' own sector, agriculture, and a sense of duty. These motives formed also the highest rated factors, the Conservation and environmental reputation motivation factor and the Social factor, which both also had a positive relation with the stated acceptance of the new measure. The results indicate that farmers see environmental matters as part of their profession in both ways: as an important condition for continuation and success of their sector, in addition to conservation as such. The implication of this view might be the cooperative and accommodating attitude to participate and contribute to creating solutions, which might be beneficial for farmers as well. Hasler et al. (2017) point to the "perceived need for action" and pressure which farmers may experience in the center of discussions of environmental matters in agriculture. Literature about drivers for co-innovation points out to similar features: co-innovators in different fields can be motivated by awareness of the problem and feeling of responsibility (Voorberg et al. 2015), reputational matters (Bin, 2013; Nambisan et al. 2010; Lakhani & von Hippel, 2003) and by need for a better "product", that brings benefits (Bin, 2013).

According to the answers, the monetary compensation for the efforts in the pilot was less important than most other reasons. For example, will to act as a forerunner, impact the implementation and share expertise were rated more important. Using gypsum was cost free for farmers and according to earlier experiments, there was a possibility for improvement of soil structure and as gypsum contains sulphur, an opportunity to have free sulphur supplement. These were the immediate direct viable benefits. Farmers did point to the risks that they were worried about, but participants were insured against any possible damages and there was also earlier research and scientific authority behind the pilot and through initiators.

The composed four motivational factors for reasons to participate were mostly parallel to researched motivation factors for adoption of conservation practices (Greiner et al., 2009, 2011) and categorized farming values (Maybery, 2005), i.e. factors related to conservation, economic and social motivations. In addition to these, the asked motivational statements formed Influencing as a practicing

farmer expert motivation -factor, which related to similar the motivations as in user innovation studies (Bin, 2013; Nambisan et al. 2010; Füller, 2006; Lakhani & von Hippel, 2003). The conservation factor in this study was partly also about strengthening the farming sector, which is understandable as the question is about livelihood and business. Still, similarly to findings of Maybery et al. (2005), the purely financial motivation (earning monetary compensation) had a strong negative correlation with the conservation factor.

Predictors of acceptance

The answers to the questions whether farmers would use gypsum in the future, were important indicator of acceptance to the stakeholders. Answers gave information also about possible difficulties or setbacks, which might have resulted in decrease of stated acceptance.

As noted earlier, the Conservation and environmental reputation motivation factor and the Social factor, which both had a positive relation with the stated acceptance and high scores on included motivations, seemed to predict acceptance. Demographic factors, or factors related to farming, did not seem to divide participating farmers in respect of acceptance. Neither did earlier awareness about the method, which according to literature (Atari et al. 2009) enhances acceptance. As all farmers had received plenty of information during the recruitment process and in farmer meetings, this may have balanced the differences in the matter.

Out of the attitudinal statements, the perceptions that gypsum is an effortless measure for water protection and that local people had taken a positive attitude towards it, increased the odds of stated acceptance the most. Also, according to literature, easiness of the new measures' implementation (Defrancesco et al, 2008; Vanslembrouck et al. 2002), as well as local stakeholders' and neighbours' attitudes (Krom, 2017; Atari et al., 2009) are important factors for farmers. Surprisingly, the perceptions related to whether agricultural methods have environmental impacts on water bodies or belief in the effect of gypsum on reducing nutrient loading did not significantly relate to acceptance. This may indicate that not all environmentally conscious farmers necessarily find gypsum the best option. On the other hand, farmers who doubt the impact of agriculture on nutrient loading, might be willing to use gypsum, if they find it useful for other reasons – e.g., for agronomical benefits or that they find it a better option compared to other agri-environmental methods.

Farmers' views concerning the dialog with pilot initiators were related positively to their acceptance of the measure as well. Similar outcomes are found in literature concerning collaborative agricultural schemes (Krom, 2017; Blackstock et al., 2010).

Farmers pointed out to their different worries concerning gypsum, but these matters did not affect the acceptance. One possible implication is that, by pointing out to their worries, farmers expressed that these matters (costs, funding, gypsum's effect on soil and yield) should be paid attention and taken into account in the future.

Farmers didn't encounter any major problems with the logistical process and minor difficulties did not affect the acceptance. With more challenging weather conditions, the result might have been different. After the first year of gypsum spreading, farmers were able to observe whether gypsum had had any impacts on soil or yield. Perceptions of positive impacts did increase the odds of acceptance statistically significantly. Agrological benefits do motivate to conservation practice adoption according to Reimer et al. (2014) as well.

The stated acceptance of the gypsum amendment of fields (measured by "I would use...") did not change significantly during the pilot and between the three yearly surveys. This implies that farmers didn't encounter any experiences that might have changed their perceptions about gypsum considerably, either positively or negatively. In the last questionnaire, around 55 percent of farmers still pointed out the need for more experience with the effect of gypsum as a conservation measure before able to use it reliably. This indicates that farmers welcome more and more long-standing research on this matter.

Critical evaluation of the study

The findings of this study are based on questionnaire responses of farmers in the pilot area. This was a limited group that was in frequent dialogue with the pilot initiators and from the very beginning to the last questionnaire. Farmers were also compensated for their efforts in the pilot. The events and findings related to the pilot got extensive media attention during the project. These matters may have influenced farmers' answers to some extent.

The sample size for factor analysis was small (48) compared to the general guidelines. This led to sensitivity of the results – even small changes like one missing respondent may affect the factor extraction. However, as the main objective was to form reasonable factors and data reduction and not to test any preconceived hypotheses, the main goal was achieved.

Conclusions

The conceptual framework of this study (in Figure 2) was built based on the findings from the scientific literature and to some extent confirmed by the analysis of this study. Willingness to adopt a new agricultural measure is a function of farm and farmer characteristics (Sattler & Nagel, 2010; Vanslembrouck et al. 2002), characteristics of the practice (Greiner & Gregg, 2011; Sattler & Nagel, 2010; Vanslembrouck et al. 2002) and surrounding circumstances (Sattler & Nagel, 2010; Vanslembrouck et al. 2002). Moreover, according to literature farmers are a heterogeneous group, even on the same land area (Blacktock et al, 2010; Defrancesco et al., 2008; Maybery et al. 2005). This conclusion was confirmed also in this study. As agri-environmental cultural conservation measures studied in the previous literature differ widely from each other, it is not straightforward to generalize from different cases. Moreover, the scientific literature about co-innovation applied to products on totally different fields. Still similar drivers for the participation in the co-creation of the eco-innovation were confirmed using the empirical data collected from the farmers in the gypsum pilot area.

It can be concluded that as a group, the pilot farmers showed wide acceptance towards the gypsum amendment. This implies that acceptance among farmers in general might be expected as well. Although not all farmers agreed on the stated acceptance ("I would use..."), they agreed to participate in the pilot and enhance the innovation process for a new water protection measure. Farmers acted as an example and a test group for policy makers and other stakeholders, also including other farmers. The experiment led to funding of new large-scale pilot projects through which furthering the wider scale use is possible. Regarding pilot as part of an innovation process, it succeeded in its objectives to enhance wider scale use of gypsum. From social innovation point of view, it succeeded in involving farmers in the innovation process, also farmers who had doubts about the new measure, and creating platform for dialog. Involving "users" in the process enabled getting their onsite experiences and expertise as part of the experiment.

The pilot farmers decided to act as co-innovators and contribute in enhancing a solution to a problem

they recognized, although not all farmers necessarily acknowledged the agricultural nutrient loadings. Farmers contribution was essential in enabling the implementation of the pilot and the knowledge they produced by sharing their experiences, observations and perceptions was an integral part of the innovation process. Drivers for their participation and acceptance provided knowledge on how farmers responded to the innovation process of gypsum amendment as a new potential water protection measure, how farmers experienced the use of gypsum on their fields and how they perceived it after their own onsite experience. The innovation process and research on gypsum continues in other gypsum projects which were furthered based on the results and experiences in the SAVE project.

References

Aakkula, J., Aakkula, J., & Leppänen, J. (.). (2014). Maatalouden ympäristötuen vaikuttavuuden seurantatutkimus (MYTVAS 3) - loppuraportti maa- ja metsätalousministeriö. Retrieved from http://urn.fi/URN:ISBN:978-952-453-852-7

Atari, D. O. A., Yiridoe, E. K., Smale, S., & Duinker, P. N. (2009). What motivates farmers to participate in the Nova Scotia environmental farm plan program? Evidence and environmental policy implications. *Journal of Environmental Management; J Environ Manage, 90*(2), 1269-1279. doi:10.1016/j.jenvman.2008.07.006

Baars, T. (2011). Experiential science; towards an integration of implicit and reflected practitioner-expert knowledge in the scientific development of organic farming. *Journal of Agricultural and Environmental Ethics, 24*(6), 601-628. doi:10.1007/s10806-010-9281-3

Baltic Marine Environment Protection Commission (Helsinki Commission, - HELCOM).Challenges of agriculture in the baltic. Retrieved from https://helcom.fi/action-areas/agriculture/basic-facts/

Bin, G. (2013). A reasoned action perspective of user innovation: Model and empirical test. *Industrial Marketing Management, 42*(4), 608-619. doi:10.1016/j.indmarman.2012.10.001

Blackstock, K. L., Ingram, J., Burton, R., Brown, K. M., & Slee, B. (2010). Understanding and influencing behaviour change by farmers to improve water quality. *The Science of the Total Environment; Sci Total Environ, 408*(23), 5631-5638. doi:10.1016/j.scitotenv.2009.04.029

Bock, B. B. (2012). Social innovation and sustainability; how to disentangle the buzzword and its application in the field of agriculture and rural development. *Studies in Agricultural Economics (Budapest), 114*, 57-63.

Bossle, M. B., Dutra de Barcellos, M., Vieira, L. M., & Sauvée, L. (2016). The drivers for adoption of eco-innovation. *Journal of Cleaner Production, 113*, 861-872. doi:10.1016/j.jclepro.2015.11.033

Cavalli, N. (2007). The symbolic dimension of innovation processes. *The American Behavioral Scientist (Beverly Hills), 50*(7), 958.

Chalmers, D. (2012). Social innovation: An exploration of the barriers faced by innovating organizations in the social economy. *Local Economy, 28*(1), 17-34. doi:10.1177/0269094212463677

Chesbrough, H., Vanhaverbeke, W., & West, J. (2008). *Open innovation : Researching a new paradigm*. New York: Oxford University Press.

Chouinard, H. H., Paterson, T., Wandschneider, P. R., & Ohler, A. M. (2008). Will farmers trade profits for stewardship? heterogeneous motivations for farm practice selection. *Land Economics, 84*(1), 66-82. doi:10.3368/le.84.1.66

De Krom, M. (2017). Farmer participation in agri-environmental schemes : Regionalisation and the role of bridging social capital. *Land use Policy, 60*(C) doi:10.1016/j.landusepol.2016.10.026

Defrancesco, E., Gatto, P., Runge, F., & Trestini, S. (2008). Factors affecting farmers? Participation in agri-environmental measures: A Northern Italian perspective. *Journal of Agricultural Economics, 59*(1), 114-131. doi:10.1111/j.1477-9552.2007.00134.x

del Río, P., Peñasco, C., & Romero-Jordán, D. (2016). What drives eco-innovators? A critical review of the empirical literature based on econometric methods. *Journal of Cleaner Production, 112*, 2158-2170. doi:10.1016/j.jclepro.2015.09.009

DiStefano, C., Zhu, M., & Mindrila, D. (2009). Understanding and using factor scores: Considerations for the applied researcher. *Practical Assessment, Research & Evaluation, 14*(20), 1-11.

EIP-AGRI, 2014. The European innovation partnership ‘‘agricultural productivity and sustainability’’ or EIP-AGRI and the service point. In: Proceedings: Workshop Establishing Operational Groups under Rural Development Programmes

Ekholm, P., Valkama, P., Jaakkola, E., Kiirikki, M., Lahti, K., & Pietola, L. (2012). Gypsum amendment of soils reduces phosphorus losses in an agricultural catchment. *Agricultural and Food Science, 21*(3), 279-291. doi:10.23986/afsci.6831

Espinosa-Goded, M., Barreiro-Hurlé, J., & Ruto, E. (2010). What do farmers want from agri-environmental scheme design? A choice experiment approach. *Journal of Agricultural Economics, 61*(2), 259-273. doi:10.1111/j.1477-9552.2010.00244.x

European Commission (EC), the United Nations Environment Programme (UNEP).Inspiring Dialogues for Eco-InnovationeContext. 15th Forum on Eco-Innovation and the UNEP Roundtable on Eco-Innovation. Available at:http://ec.europa.eu/environment/ecoinnovation2013/2nd_forum/inspiring_0.html

Fabrigar, L. R., & Wegener, D. T. (2012). *Exploratory factor analysis*. Oxford ; New York: Oxford University Press. Retrieved from https://helka.finna.fi/Record/helka.2869966

Fagerberg, J., Fosaas, M., & Sapprasert, K. (2012). Innovation: Exploring the knowledge base. *Research Policy, 41*(7), 1132-1153. doi:10.1016/j.respol.2012.03.008

Fishbein, M., Ajzen, I., 1975. Belief, Attitude, Intention, and Behavior: an Introduction to Theory and Research. Addison-Wesley, Reading, MA.

Fuller, J. (2006). Why consumers engage in virtual new product developments initiated by producers. Paper presented at the , *33* 639-646. Retrieved from https://helka.finna.fi/PrimoRecord/pci.proquest1560854257

Ghisetti, C., Marzucchi, A., & Montresor, S. (2015). The open eco-innovation mode. an empirical investigation of eleven European countries. *Research Policy, 44*(5), 1080-1093. doi:10.1016/j.respol.2014.12.001

Greiner, R. (2011). Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from Northern Australia. *Land use Policy, 28*(1), 257-265. doi:10.1016/j.landusepol.2010.06.006

Greiner, R., & Gregg, D. (2011). Farmers' intrinsic motivations, barriers to the adoption of conservation practices and effectiveness of policy instruments: Empirical evidence from Northern Australia. *Land use Policy, 28*(1), 257-265. doi:10.1016/j.landusepol.2010.06.006

Greiner, R., Patterson, L., & Miller, O. (2009). Motivations, risk perceptions and adoption of conservation practices by farmers. *Agricultural Systems, 99*(2-3), 86-104. doi:10.1016/j.agsy.2008.10.003

Gross, C. (2007). Community perspectives of wind energy in Australia: The application of a justice and community fairness framework to increase social acceptance. *Energy Policy, 35*(5), 2727-2736. doi:10.1016/j.enpol.2006.12.013

Hasler, K., Olfs, H., Omta, O., & Bröring, S. (2017). Drivers for the adoption of different eco-innovation types in the fertilizer sector: A review. *Sustainability (Basel, Switzerland), 9*(12), 2216. doi:10.3390/su9122216

HELCOM, Our Baltic Sea. Retrieved (2020, November 22) from http://stateofthebalticsea.helcom.fi/in-brief/our-baltic-sea/

Hienerth, C. (2014). User community vs. producer innovation development efficiency: A first empirical study. *Research Policy, 43*(1), 190-201. doi:10.1016/j.respol.2013.07.010

Hippel, Eric. (2007). The Sources of Innovation. Technology and Culture. 31. 10.1007/978-3-8349-9320-5_10.

Home, R., Balmer, O., Jahrl, I., Stolze, M., & Pfiffner, L. (2014). Motivations for implementation of ecological compensation areas on swiss lowland farms. *Journal of Rural Studies, 34*, 26-36. doi:10.1016/j.jrurstud.2013.12.007

Horbach, J., Rammer, C., & Rennings, K. (2012). Determinants of eco-innovations by type of environmental impact — the role of regulatory push/pull, technology push and market pull. *Ecological Economics, 78*, 112-122. doi:10.1016/j.ecolecon.2012.04.005

Hynes, S. (2009). Modelling farmers' participation in an agri-environmental scheme using panel data: An application to the rural environment protection scheme in Ireland. *Journal of Agricultural Economics, 60*(3), 546-562. doi:10.1111/j.1477-9552.2009.00210.x

Hyytiäinen, K., & Ollikainen, M. (2012). *Taloudellinen näkökulma itämeren suojeluun*. Helsinki: Ympäristöministeriö.

Jaakkola, E., Tattari, S., Ekholm, P., Pietola, L., Posch, M., & Bärlund, I. (2012). Simulated effects of gypsum amendment on phosphorus losses from agricultural soils. *Agricultural and Food Science, 21*(3), 292-306. doi:10.23986/afsci.6773

Kemp, R.; Pearson, P. Final Report of the MEI Project Measuring Eco Innovation; UM Merit: Maastricht, The Netherlands, 2008

Klievink, B., & Janssen, M. (2014). Developing multi-layer information infrastructures: Advancing social innovation through public-private governance. *Information Systems Management, 31*(3), 240-249. doi:10.1080/10580530.2014.923268

Knickel, K., Brunori, G., Rand, S., & Proost, J. (2009). Towards a better conceptual framework for innovation processes in agriculture and rural development: From linear models to systemic approaches. *The Journal of Agricultural Education and Extension, 15*(2), 131-146. doi:10.1080/13892240902909064

Lakhani, K. R., & von Hippel, E. (2003). How open source software works: "free" user-to-user assistance. *Research Policy, 32*(6), 923-943. doi:10.1016/s0048-7333(02)00095-1

Lötjönen, S., & Ollikainen, M. (2019). Multiple-pollutant cost-efficiency: Coherent water and climate policy for agriculture. *Ambio, 48*(11), 1304-1313. doi:10.1007/s13280-019-01257-z

Maybery, D., Crase, L., & Gullifer, C. (2005). Categorising farming values as economic, conservation and lifestyle. *Journal of Economic Psychology, 26*(1), 59-72. doi:10.1016/j.joep.2003.10.001

Moulaert, F., Martinelli, F., Swyngedouw, E., & Gonzalez, S. (2016). Towards alternative model(s) of local innovation. *Urban Studies (Edinburgh, Scotland), 42*(11), 1969-1990. doi:10.1080/00420980500279893

Nambisan, S., & Baron, R. A. (2010). Different roles, different strokes: Organizing virtual customer environments to promote two types of customer contributions. *Organization Science (Providence, R.I.), 21*(2), 554-572. doi:10.1287/orsc.1090.0460

Nielsen, K. R., Reisch, L. A., & Thøgersen, J. (2016). Sustainable user innovation from a policy perspective: A systematic literature review. *Journal of Cleaner Production, 133*, 65-77. doi:10.1016/j.jclepro.2016.05.092

OECD, & Statistical Office of the European Communities. (2005). *Oslo manual* doi:https://doi.org/https://doi.org/10.1787/9789264013100-en

Pannell, D. J., & Claassen, R. (2020). The roles of adoption and behavior change in agricultural policy. *Applied Economic Perspectives and Policy, 42*(1), 31-41. doi:https://doi.org/10.1002/aepp.13009

Pierpaoli, E. (2013). Drivers of precision agriculture technologies adoption: A literature review. *Procedia Technology, 8*(C), 61-69. doi:10.1016/j.protcy.2013.11.010

Polanyi, M 1966. The Tacit Dimension. London, Routledge. (University of Chicago Press. ISBN 978-0-226-67298-4. 2009 reprint)

Project SAVE webpage (2017, February 28), SAVE-hankkeen loppuraportti [Summary of experiences in the pilot]. Retrieved from https://blogs.helsinki.fi/save-kipsihanke/files/2019/03/SAVE-hankkeen-loppuraportti-2018.pdf

Pol, E., & Ville, S. (2009). Social innovation: Buzz word or enduring term? *The Journal of Socio-Economics, 38*(6), 878-885. doi:10.1016/j.socec.2009.02.011

Rehman, T. (2007). Identifying and understanding factors influencing the uptake of new technologies on dairy farms in SW England using the theory of reasoned action. *Agricultural Systems, 94*, 281-293. Retrieved from https://helka.finna.fi/PrimoRecord/pci.faoagrisUS201300784248

Reimer, A. P., Reimer, A. P., Prokopy, L. S., & Prokopy, L. S. (2014). Farmer participation in U.S. farm bill conservation programs. *Environmental Management (New York); Environ Manage, 53*(2), 318-332. doi:10.1007/s00267-013-0184-8

Rennings, K. (2000). Redefining innovation — eco-innovation research and the contribution from ecological economics. *Ecological Economics, 32*(2), 319-332. doi:10.1016/S0921-8009(99)00112-3

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York: Free Press.

Sattler, C., & Nagel, U. J. (2010). Factors affecting farmers' acceptance of conservation measures—A case study from North-Eastern Germany. *Land use Policy, 27*(1), 70-77. doi:10.1016/j.landusepol.2008.02.002

Schumpeter, J. A., & Elliott, J. E. (1996). *The theory of economic development : An inquiry into profits, capital, credit, interest, and the business cycle*. New Brunswick, (U.S.A.): Transaction Publishers.

Schumpeter, J., (1942). Capitalism, Socialism and Democracy. George Allen & Unwin, London.

Sennett, R. (2008).Handwerk(432 p.). Berlin: Berlin Verlag.

Smith, A., Voß, J., & Grin, J. (2010). Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research Policy, 39*(4), 435-448. doi:10.1016/j.respol.2010.01.023

Stosic, B., Milutinovic, R., Zakic, N., & Zivkovic, N. (2016). Selected indicators for evaluation of eco-innovation projects. *Null, 29*(2), 177-191. doi:10.1080/13511610.2016.1157682

Suomen meriympäristön tila 2018 (2018). In Korpinen S., Laamanen M., Suomela J., Paavilainen P., Lahtinen T. and Ekebom J.(Eds.), Suomen ympäristökeskus. Retrieved from http://hdl.handle.net/10138/274086

Unay-Gailhard, İ, & Bojnec, Š. (2016). Sustainable participation behaviour in agri-environmental measures. *Journal of Cleaner Production, 138*, 47-58. doi:10.1016/j.jclepro.2015.09.003

van Dijk, William F. A. (2015). Collective agri-environment schemes: How can regional environmental cooperatives enhance farmers' intentions for agri-environment schemes? *Land use Policy, 42*, 759-766. doi:10.1016/j.landusepol.2014.10.005

Vanslembrouck, I., Van Huylenbroeck, G., & Verbeke, W. (2002). Determinants of the willingness of belgian farmers to participate in agri-environmental measures. *Journal of Agricultural Economics, 53*(3), 489-511. doi:10.1111/j.1477-9552.2002.tb00034.x

Voorberg, W. H., Bekkers, V. J. J. M., & Tummers, L. G. (2015). A systematic review of co-creation and co-production: Embarking on the social innovation journey. *Public Management Review, 17*(9), 1333.

Wüstenhagen, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation: An introduction to the concept. *Energy Policy, 35*(5), 2683-2691. doi:10.1016/j.enpol.2006.12.001